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INVESTIGATION OF THE WAVELENGTH DEPENDENCE OF AEROSOL OPTICAL DEPTHS OVER BAY OF BENGAL AND THE ARABIAN SEA

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Introduction

Atmospheric aerosols are produced in the atmosphere both from natural sources as well as due to anthropogenic activities. Due to their short lifetimes (about a week) and widely distributed sources, they exhibit large spatial and temporal variability. Atmospheric aerosols affect the earth-atmosphere radiation budget by scattering and absorbing the incoming solar radiation, by acting as cloud condensation nuclei, and altering the cloud microphysical properties. The direct and indirect effect of aerosols produces large uncertainty in the prediction of climate change.

The densely populated Indian subcontinent and the surrounding regions are rich sources for many kinds of aerosols of both natural and anthropogenic origin such as mineral dust, soot, nitrate, sulfate and organic aerosols. A number of observational campaigns have been conducted over the Indian subcontinent and surrounding oceanic regions in recent times to investigate the role of aerosols in altering the atmospheric radiation budget and the cloud properties, Ocean Experiment INDOEX, Land Campaigns (LC) LC-I and LC-II, to name a few. Recently, an Integrated Campaign for Aerosols, gases and Radiation Budget (ICARB) was conducted over Bay of Bengal and the Arabian Sea during the premonsoon season of March-May 2006 to study the different aerosol species presents over India and surrounding oceanic regions and to identify the main natural and anthropogenic sources of these particles.

Measurements of aerosol optical depth (AOD) was conducted using a hand held sun photometer (*Ramachandran and Jayaraman, 2003)* at seven wavelengths centered around 0.40, 0.50, 0.65, 0.75, 0.875, 0.95 and 1.02 μm during ICARB over Bay of Bengal and the Arabian Sea.

The spectral variation of AOD can be represented by Ǻngström power law which gives information about the particle size distribution.

$$\tau = \beta\lambda^{-\alpha} \qquad (1)$$

The power law is valid if the particle size distribution follows Junge power law and the law is well fitted for short spectral ranges. An analysis of spectral measurement of AOD in locations dominated by biomass burning, urban, or desert dust aerosols, a significant curvature in the ln τ versus ln λ relationship was observed *(Eck et al., 1999).* In the present study, an attempt has been made to show that, for large spectral range, departure from power law behavior from AOD is observed, which is dependent on the aerosol type. This departure introduces a curvature on ln τ versus ln λ curve. And a second order fit to the ln τ versus ln λ provides excellent agreement with measured AOD while a linear fit yields a significant differences with measured AOD *(Eck et al, 2001; Kaskaoutis and Kambezidis, 2006; Kaskaoutis et al., 2006).*

Methodology

From the measured AODs, daily mean AOD are calculated at seven wavelengths over Bay of Bengal and the Arabian Sea. The mean AOD spectra was obtained for both the oceans, a linear fit to the ln τ versus ln λ is observer for both the oceanic region. It is found that on 7th April (Bay of Bengal) when the deviation is significant linear fit is underestimating AOD at smaller and larger wavelength (Figure 1) indicating presence of accumulation mode particles (*Kaskaoutis and Kambezidis, 2006)* while on 26th April (Arabian Sea) curvature is very small and the polynomial fit tends to be linear. This happens if the aerosol distribution is binomial and dominated by coarse mode particles *(Eck et al, 1999).*

A second order polynomial equation was fitted to ln τ versus ln λ data which is of the form (*Kaskaoutis and Kambezidis, 2006*),

$$\ln \tau = \alpha_2 \ln\lambda^2 + \alpha_1 \ln\lambda + \alpha_0 \qquad (2)$$

and the coefficients ($\alpha_0, \alpha_1, \alpha_2$) are obtained for all the days over both the oceans for entire cruise period.

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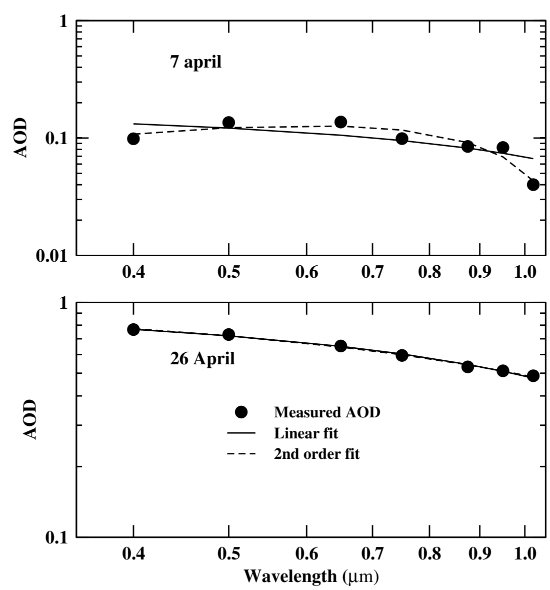

(Figure 1 Mean AOD spectra at seven wavelengths for two different days over Bay of Bengal and the Arabian Sea, their linear and second order fits.)

While, on 26th April, the second order polynomial curve becomes nearly linear which happens if the turbidity is high. It was observed earlier that for bimodal size distribution, under high turbidity condition, where the coarse mode dominates, the curvature is very small and the polynomial fit tends to be linear *[Eck et al., 1999]*. In our case the high turbidity can arise due to high wind speed, which can increase sea salt co

Conclusion

Aerosol optical depth measurements were conducted over Bay of Bengal and the Arabian Sea during March-May, 2006. The wavelength dependence of Ångström exponent, α, is calculated using a linear fit. A significant curvature is observed in the ln τ versus ln λ curve which depend on atmospheric turbidity and aerosol properties. The spectral variation of ln τ versus ln λ curve is analysed at seven wavelengths to investigate the cause and the nature of the significant curvature. It is found that a second order fit gives an excellent agreement with the observed variation of AOD. The curvature of the curve is analysed for two different days over two different regions to understand the spatial and temporal variations of aerosol properties.

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